

CLAIMS:

1. A non-contact method for determining a tension in a target strand, comprising the steps of:
 - 5 providing a plurality of radiation detecting elements each arranged to provide an output signal for indicating a level of radiation incident at a respective detecting element;
 - 10 detecting radiation incident at said plurality of detecting elements when said strand vibrates;
 - repeatedly identifying one or more detecting elements providing an output indicating a predetermined characteristic; and
 - 15 determining the tension in said strand responsive to which of said detecting elements are identified.
2. The method as claimed in claim 1 further comprising the steps of:
 - 20 providing a radiation source to illuminate a portion of said strand; and
 - detecting radiation reflected from said strand.
3. The method as claimed in claim 1 further comprising the steps of:
 - 25 providing a radiation source to illuminate a portion of said strand; and
 - detecting radiation un-obsured by said strand.
4. The method as claimed in any one of claims 1 to 3 30 wherein said step of repeatedly identifying comprises the steps of:
 - detecting a level of incident radiation at all of said plurality of detecting elements;

identifying which of said detecting elements from all of said plurality of detecting elements, has the highest level of incident radiation; and

repeating the steps of detecting a level of incident 5 radiation at all of said detecting elements and identifying said highest level of incident radiation detecting element over a period of time.

5. The method as claimed in any one of claims 1 to 3 10 wherein said step of repeatedly identifying comprises the steps of:

detecting a level of incident radiation at all of said plurality of detecting elements;

15 identifying which of said detecting elements from all of said plurality of detecting elements has the lowest level of incident radiation; and

repeating the steps of detecting a level of incident 20 radiation at all of said plurality of detecting elements and identifying said lowest level of incident radiation detecting element over a period of time.

6. The method as claimed in claim 4 or 5 further comprising the steps of:

25 providing an output indicating the position of an identified detecting element over said period of time; and

determining a frequency associated with a change in position of said identified element.

30 7. The method as claimed in claim 6 further comprising the steps of:

calculating said tension according to the equation

$$T = \rho \left(\frac{2\ell f}{n} \right)^2$$

where T is the tension in the strand, ρ is the linear density of the strand, ℓ is the distance between two points of the strand, f is the natural frequency of vibration and n is an integer value corresponding to the mode of vibration of the strand.

8. The method as claimed in any one of claims 1 to 7 further comprising the steps of:
 - 10 supporting said strand at two spaced-apart locations via a pair of guide supports.
 9. The method as claimed in claim 8 further comprising the steps of:
 - 15 generating a vibration of said strand by running said strand in a direction parallel to a main axis of the strand and across guide supports arranged substantially perpendicular to the direction of running.
 - 20 10. A method as claimed in claim 8 further comprising the steps of:
 - generating a vibration of said strand by displacing a portion of said strand away from a resting position and permitting said strand to recover to the resting 25 position.
 11. The method as claimed in any one of claims 2 or 3 further comprising locating said strand at a desired location with respect to said plurality of detecting 30 elements prior to determining said tension.
 12. The method as claimed in claim 11 further comprising the steps of:

providing two or more radiation sources and locating said strand at said desired location by the steps of:

locating said plurality of detector elements at various locations with respect to said strand;

5 detecting when an intensity of reflected or transmitted radiation reaches a predetermined level;

selecting a position for said plurality of detector elements when the intensity reaches said predetermined level; and

10 locating said plurality of detection elements at said selected position.

13. Apparatus for determining a tension in a strand comprising:

15 a plurality of radiation detection elements each for providing an output signal responsive to a respective level of incident radiation;

means for identifying one or more of said detecting elements providing a respective output indicating a 20 predetermined characteristic; and

means for determining the tension in said strand responsive to which of said detecting elements is identified.

25 14. The apparatus as claimed in claim 13 further comprising:

a radiation source for illuminating a portion of said strand.

30 15. The apparatus as claimed in claim 13 further comprising:

a lens for focussing radiation onto said radiation detecting elements.

16. The apparatus as claimed in any one of claims 13 to 15 wherein said means for identifying comprises:

5 a comparator arranged to consecutively compare the output from the plurality of detecting elements with a repeatedly updated previously stored value and provide an enable signal to indicate when a detecting element provides a respective output indicating said predetermined characteristic.

10 17. The apparatus as claimed in claim 16 further comprising:

a data store arranged to store the repeatedly updated value.

15 18. The apparatus as claimed in claim 17 further comprising:

a counter arranged to output a running digital count signal, each value of said count signal indicating a respective one of said detecting elements.

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19. The apparatus as claimed in claim 18 further comprising:

25 a latch arranged to receive said count signal and said enable signal and to output a count value responsive to said enable signal.

20. The apparatus as claimed in any one of claims 13 to 19 wherein said means for determining the tension comprises:

30 a frequency analyser for receiving a signal indicating said one or more identified detecting elements and, from said signal, determining a frequency of vibration of said strand.

21. The apparatus as claimed in any one of claims 13 to 20 wherein said strand comprises a tensioned yarn.
22. The apparatus as claimed in any one of claims 13 to 5 20 wherein said strand comprises a textile yarn.
23. The apparatus as claimed in any one of claims 13 to 20 wherein said strand comprises a running strand.
- 10 24. The apparatus as claimed in any one of claims 13 to 23 wherein said plurality of radiation detecting elements comprises a charge coupled device (CCD) or photodiode type linear array.
- 15 25. The apparatus as claimed in any one of claims 13 to 24 wherein said radiation source comprises one or more light emitting diodes.
26. A method substantially as hereinbefore described 20 with reference to the accompanying drawings.
27. Apparatus constructed and arranged substantially as hereinbefore described with reference to the accompanying drawings.